95th ANNUAL REPORT OF THE STATE GEOLOGIST

of

INDIANA GEOLOGICAL SURVEY
DEPARTMENT OF NATURAL RESOURCES

for

July 1, 1970 - June 30, 1971

GEOLOGICAL SURVEY
NINETY-FIFTH ANNUAL REPORT OF THE STATE GEOLOGIST

PERSONNEL

Permanent Personnel

Administration

John B. Patton . . . . . State Geologist
Maurice E. Biggs . . . . . Assistant State Geologist
Mary Beth Fox . . . . . Mineral Statistician
Theodore H. Appleton . . . . . Accountant
Marguerite Trisler . . . . . Senior Accounts Clerk

Coal Section

Charles E. Wier . . . . . Geologist and Head
Harold C. Hutchison . . . . . Geologist
Richard L. Powell . . . . . Geologist
Marvin T. Iverson . . . . . Geological Assistant
Bonnie Burks . . . . . Secretary

Drafting and Photography Section

William H. Moran . . . . . Chief Draftsman and Head
Robert E. Judah . . . . . Geological Artist-Draftsman
Muriel M. Malone . . . . . Geological Draftsman
John E. Peace . . . . . Senior Geological Draftsman
Roger L. Purcell . . . . . Senior Geological Draftsman
George R. Ringer . . . . . Photographer

Educational Services

Reevan Dee Rarick . . . . . Geologist

Geochemistry Section

Richard K. Leininger . . . . . Geochemist and Head
Maynard E. Coller . . . . . Chemist
Elmer E. Craig . . . . . Geochemical Assistant
Rosalie V. Easton . . . . . Secretary
(Shared with Industrial Minerals Section)
Margaret V. Golde . . . . . Instrumental Analyst
Louis V. Miller . . . . . Coal Chemist
Alfred E. White . . . . . Geochemical Assistant

Geology Section

Robert H. Shaver . . . . . Paleontologist and Head
Ned K. Bleuer . . . . . Glacial Geologist
Henry H. Gray . . . . . Head Stratigrapher
Edwin J. Hartke . . . . . Environmental Geologist
(from September 1, 1970)
John R. Hill . . . . . Glacial Geologist
(from December 1, 1970)
Alan Horowitz . . . . . Curator of Paleontology
Carl B. Rexroad . . . . . Paleontologist
Allan F. Schneider . . . . . Glacial Geologist
(to August 7, 1970)
Martha N. Smith . . . . . Secretary

Geophysics Section

Maurice E. Biggs . . . . . Geophysicist and Head
Robert F. Blakely . . . . . Geophysicist
Galen Cramer . . . . . Assistant Driller
Linda Dro . . . . . Secretary
(from December 1, 1970)
Kathleen Hartley . . . . . Secretary
(to December 1, 1970)
Clarence Haskins . . . . . Driller
John R. Helms . . . . . Geophysical Assistant
Charles Miller . . . . . Instrument Maker
Joseph F. Whaley . . . . . Geophysicist

Industrial Minerals Section

Donald D. Carr . . . . . Geologist and Head
Curtis H. Ault . . . . . Geologist
George S. Austin . . . . . Geologist
(from June 16, 1971)
Rosalie V. Easton . . . . . Secretary
Michael C. Moore . . . . . Geologist
Lawrence F. Rooney . . . . . Geologist and Head
(to August 14, 1970)

Petroleum Section

T. A. Dawson . . . . . Geologist and Head
Leroy E. Becker . . . . . Geologist
M. Ruth Butcher . . . . . Secretary and Curator of Records
Gerald L. Carpenter . . . . . Geologist
James T. Cazee . . . . . Geological Assistant
Andrew J. Hreha . . . . . Geologist
Stanley J. Keller . . . . . Geologist

Petroleum Section (continued)

Timothy L. Lawrence . . . . . Geological Assistant
Vivian McGuire . . . . . Senior Curator of Records
Dan M. Sullivan . . . . . Geologist
James Thrasher . . . . . Geological Assistant

Publications Section

Gerald S. Woodard . . . . . Editor and Head
Rebecca B. Gaidosz . . . . . Secretary
(from June 30, 1971)
Donna C. Schultz . . . . . Senior Sales and Records Clerk
M. Jane Tuke . . . . . Secretary
(to June 18, 1971)

Seasonal Personnel

Coal Section

John Bassett . . . . . Cave Research Assistant
(August 31, 1970 to October 24, 1970)
Richard Brown . . . . . Cave Research Assistant
(February 11, 1971 to May 27, 1971)
Rick Donica . . . . . Geological Assistant
(September 18, 1970 to June 18, 1971)
Stephen E. Eikenberry . . . . . Geological Assistant
(October 5, 1970 to June 17, 1971)
Thomas Hare . . . . . Geological Assistant
(August 6, 1970 to September 12, 1970)
David V. Lewis . . . . . Geological Research Assistant
(July 19, 1970 to September 18, 1970)
David Morton . . . . . Lab Assistant
(July 8, 1970 to August 10, 1970)
Ted Wilson . . . . . Geological Research Assistant
(October 20, 1971 to May 5, 1971)

Geochemistry Section

Murphy Dupler . . . . . Lab Assistant
(September 14, 1970 to June 30, 1971)
Carrie Foley . . . . . Lab Technician
(July 1, 1970 to June 30, 1971)
Carole Houppert . . . . . Lab Assistant
(September 13, 1970 to June 30, 1971)
Theodore Petranoff . . . . . Lab Assistant
(August 2, 1970 to February 12, 1971)

Charles Roy . . . . . Lab Assistan
(July 1, 1970 to August 1, 1970
George VanSlyke III . . . . . Lab Assistan
(September 27, 1970 to March 27, 1971
Christie York . . . . . Lab Assistan
(September 21, 1970 to June 30, 1971

Geology Section

Thomas Devine . . . . . Lab Assistan
(September 38, 1970 to May 30, 1971
Marcia Engle . . . . . Lab Assistan
(March 6, 1971 to June 30, 1971
Carolyn Haase . . . . . Lab Assistan
(September 21, 1970 to January 20, 1971
James L. Hauser . . . . . Lab Assistan
(July 1, 1970 to May 12, 1971
Richard Hoffman . . . . . Lab Assistan
(November 8, 1970 to June 3, 1971
Peggy Keller . . . . . Lab Assistant
(July 1, 1970 to August 26, 1970
Inge Merkle . . . . . Lab Assistant
(July 1, 1970 to June 30, 1971
Cathy Niles . . . . . Lab Assistant
(November 30, 1970 to June 30, 1971
Linda Niles . . . . . Lab Assistant
(July 1, 1970 to December 23, 1970
Humberto Rostworwoski . . . . . Lab Assistant
(June 8, 1971 to June 30, 1971
Charles Roy . . . . . Lab Assistant
(August 16, 1970 to September 9, 1970
Kathleen Roy . . . . . Lab Assistant
(July 1, 1970 to May 28, 1971
Janet Sheets . . . . . Lab Assistant
(July 1, 1970 to June 30, 1971
Robert Vote . . . . . Lab Assistant
(September 21, 1970 to May 4, 1971

Geophysics Section

Joan E. Buehler . . . . . Lab Assistant
(February 9, 1971 to June 30, 1971
Nancy Hasenmueller . . . . . Geologist
(September 13, 1970 to June 30, 1971
Richard Hoffman . . . . . Geophysical Assistant
(June 7, 1971 to June 30, 1971
Linda Massey . . . . . Keypunch Operator
(October 14, 1970 to June 30, 1971
Sharon McGlothlin . . . . . Keypunch Operator
(July 1, 1970 to November 13, 1970

Jan Nattier . . . . . Research Assistant
(July 1, 1970 to October 9, 1970)

Albert Rudman . . . . . Geophysicist
(July 1, 1970 to August 30, 1970)

John Sexton . . . . . Geophysical Assistant
(July 1, 1970 to August 28, 1970)

Industrial Minerals Section

Douglas Baumgardt . . . . . Field Assistant
(June 7, 1971 to June 30, 1971)

Cathy Chearhart . . . . . Lab Assistant
(September 28, 1970 to June 1, 1971)

Linda Runkle . . . . . Lab Assistant
(June 23, 1971 to June 30, 1971)

Steve Wells . . . . . Lab Assistant
(July 1, 1970 to June 1, 1971)

Petroleum Section

Larry Enochs . . . . . Geological Assistant
(July 1, 1970 to August 21, 1970)
(June 7, 1971 to June 30, 1971)

Publications Section

Thomas Kaletta . . . . . Clerk
(January 11, 1971 to June 4, 1971)

Anthony Polich . . . . . Clerk
(May 24, 1971 to June 30, 1971)

Paul E. Prichard . . . . . Clerk
(July 1, 1970 to September 11, 1970)

Kurt Von Schriltz . . . . . Clerk
(September 10, 1970 to January 15, 1971)

FINANCIAL STATEMENT

FUNCTION OR ACTIVITY	EXPENDITURE 1970-71
1. PERSONAL SERVICES	
101. Full-time Salaries	$452,237.59
101. Summer Field Work	2,105.76
101. Hourly	19,342.39
199. Work-Study	744.42
TOTAL: PERSONAL SERVICES	474,430.16
2. SERVICES OTHER THAN PERSONAL	
204. Freight	194.60
206. Dues and Subscriptions	328.40
211. Gasoline	10,169.93
215. Travel	16,481.15
220. Telephone	7,936.07
TOTAL: SERVICES OTHER THAN PERSONAL	35,110.15
3. SERVICES BY CONTRACT	
302. Printing & Binding	9,349.03
329. Insurance	8,824.16
331. Repair to Buildings	7,804.75
332. Repair to Vehicles	5,567.30
339. Repair to Laboratory & Office Equipment	1,714.81
399. Contractual Services	4,380.49
TOTAL: SERVICES BY CONTRACT	37,640.54
4. MATERIALS, SUPPLIES & PARTS	
401. Office	791.06
404. Laboratory & Shop	13,343.74
TOTAL: MATERIALS, SUPPLIES & PARTS	14,134.80
5. EQUIPMENT	
501. Office	71.50
511. Motor Vehicle	677.21
521. Laboratory & Shop	99.76
TOTAL: EQUIPMENT	848.47
CARRYOVER FROM PREVIOUS YEAR	18,475.76
TOTAL EXPENDITURES	$580,639.88

INTRODUCTION

During past years the work of the Geological Survey has been directed mainly to basic geology and to the geology of the State's mineral resources. During the 1970-71 fiscal year, however, an increasing effort was required for problems related to man's use of the earth -- environmental geology. This has not resulted totally from the sudden popularity of the "environment," but rather from the practical realization by planners and leaders that the earth must be considered in all matters of land utilization, waste disposal, and diminished accessibility to mineral resources. This work fell most heavily on the Geology Section, but also required the skills of specialists from throughout the Survey.

In all, the Geological Survey staff participated in one of the busiest years of its history in terms of service to the public. The Industrial Minerals Section, for example handled nearly 400 requests for assistance, an increase of about 60 percent over the preceeding fiscal year. Nearly all other sections experienced a similar surge in their activities. In just one month the Geology Section dealt with 15 problems related to the use of earth materials.

In addition to the direct help that was provided to citizens and groups in the State, several major accomplishments by the Survey stand out as significant during the period. In April Dr. Charles Wier completed a report on the distribution of varieties of sulfur in Indiana coals. The report was the culmination of a year's efforts in sampling, chemical analysis and laboratory study that has led to a rather broad understanding of how sulfur is distributed in Indiana coals. It concluded that the central part of Indiana's coal producing area -- Knox, Sullivan, and Vigo Counties -- has potential resources of about 2 billion tons of Coals IV and VII that could produce a cleaned coal containing less than 2 percent sulfur.

Two new regional geologic maps, the Chicago and the Vincennes 1^{o} x 2^{o} quadrangles, were sent to the printers. With the addition of those two maps, the entire western half of Indiana is covered by rather detailed geologic mapping that has aided greatly in environmental problems and studies. Other important new publications included Powell's report on the Falls of the Ohio, Henry Gray's publication dealing with glacial lake deposits in southern Indiana, and Don Carr's report on the State's sand and gravel resources. Numerous memorandum reports dealing with individual studies also were completed.

This vigorous activity on the part of the Geological Survey was accomplished despite a continuing unstable financial situation. For the fiscal year $160,000. was appropriated from the Severance Tax for the Survey, $245,320. was made available from the General Fund, but $169,920. had to be transferred from another account in the

Department of Natural Resources in order for the Geological Survey to continue operations. Such makeshift arrangements contribute to poor employee morale and a gradual slowing of the creative momentum that has been built up over the past twenty years.

ORGANIZATION AND ADMINISTRATION

The Geological Survey is headed by the State Geologist, who is responsible to the Director of the Department of Natural Resources. The organizational framework consists of three commodity sections (Coal, Industrial Minerals, and Petroleum), three research and analytical sections (Geochemistry, Geology, and Geophysics) and two service sections (Drafting and Photography and Publications). The sections differ widely in size, ranging from the Petroleum Section with 12 full-time employees and some seasonal personnel to the smallest section (Educational Services) which consists of one full-time geologist. In addition to the staff members of the sections enumerated, a few employees work directly with, or under the direction of the State Geologist.

Biennial budget requests are constructed by the State Geologist and submitted to the Director of the Department of Natural Resources, who in turn submits them to the State Budget Committee for action and transmittal to the Indiana General Assembly. Annual operating budgets of the Geological Survey also are constructed by the State Geologist and submitted to the Director for approval. Indiana University then acts as the fiscal agent for the Department of Natural Resources, and the appropriated funds are spent under the signature of the State Geologist. Records of all expenditures become part of the Accounting Department of Indiana University and are audited by the State Auditor's Office; monthly financial reports are sent to the Department of Natural Resources.

STATISTICAL SUMMARY OF ACTIVITIES FOR FISCAL 1970-71

Many of the activities of the Geological Survey can be most readily summarized by the statistical listing that follows:

Projects in progress	46
Projects completed	10
Conferences with visitors to the Survey	1,154
Man days of field work	1,297
Incoming letters	5,009
Outgoing letters	3,248
Telephone requests for information	62
Total number of vehicles	21
Total number of miles traveled in Survey vehicles	201,461
Thickness of stratigraphic sections	6,196
Public lectures	
Civic	18
Industrial	6
School	68
Other	2
Papers presented at professional meetings	6
Field trips	
In connection with conferences	71
Educational	39
News releases submitted	9
Newsletters	3
Mineral statistics questionnaires processed	800
Attendance at professional meetings	60
Exhibits prepared for special occasion	3
Samples received or collected	
Rock and minerals	708
Coal	426
Fossils	675
Identification (rocks, minerals, fossils)	337
Special rock sets for teachers	17
Rocks and minerals sets sent	235
Information packets sent	89
Gravity separation of coal	199
Polished blocks of coal made	66
Coal samples prepared	403
Coal analyses (determinations)	2,718
Samples analyzed instrumentally	1,008
Instrumental analyses (determinations)	5,172
Samples analyzed chemically	770
Chemical analyses (determinations)	2,676
Samples from cores and quarries received or collected	731
Rock analyses (magnetic, mineralogical, textural and physical)	3,449
Heavy mineral separations made	45
Physical tests on building stone	14
Physical tests on other stone	26

Seismic reflection shots	63
Feet of hole drilled	3,003
Feet of core recovered	1,905
Feet of hole augered	4,044
Feet of core collected other than by Survey	707
Feet of core described	3,345
Oil wells field checked (current)	303
Well cutting sets catalogued and filed	271
Well cores catalogued and filed	16
Strip logs made	143
Feet represented on strip logs	169,250
Camera copies made	616
Black and white prints	836
Diazo prints	6,000
Film prints	388
Color slides	91
Black and white slides	50
Photo micrographs	133
Scribecoat prints	35
Stripping film prints	283
Memorandum reports on special projects	27
Reports and maps completed for publication (in editorial process)	
Bulletins	5
Special Reports	2
Preliminary Coal Maps	1
Regional Geologic Maps	2
Published reports	
Bulletins	5
Circulars	1
Directories (IBM printout)	1
Mineral Economic Series	1
Reports of Progress	1
Special Reports	1
Published maps	
Miscellaneous maps	
New	2
Revised	3
Petroleum Exploration Maps	
Revised	56
Checked without revision	50
Preliminary Coal Maps	1
Regional Geologic Maps	2
Published reports sold	5,915
Published maps sold	8,735
Publications office customers	3,217
Announcements of publications sent	1,669
Outside publications	
Abstracts	1
Complete reports	6
Reports completed and sent to editor for outside publication	9
Abstracts completed & sent to editor for outside publication	1

COAL SECTION

Service Work and Applied Activities

Answering requests for information concerning coal and coal-bearing rocks continues to occupy a significant part of the time of members of the Coal Section. More than a third of the requests come in the form of a letter, less than a third from telephone calls, and the remainder from visits to the Survey. The requests fall into several rather broad categories: 1) from professional people from coal-oriented organizations who want to know about the distribution of coal in a specific area, the amount of coal available and the quality of the coal. 2) from representatives of industries that are not actively producing or buying coal but produce equipment or supplies or are otherwise related to the coal industry and who wish information related to the general health of the industry and the future of coal production in the State. 3) from property owners who wish to buy or sell land or buy or sell coal rights and want to know the depth, thickness, quantity and value of the coal under specific acreages. 4) from individuals, companies, or government agencies, who wish to construct buildings, roads, dams, etc. in the coal mining area and want to know how these relate to past underground and strip mining and to possible future mining or planned mining. 5) from researchers or planners who need general information related to the distribution of kinds of rocks and unconsolidated material in the coal-bearing area, quite often related to coal economics, paleobotany, invertebrate paleontology, air pollution, water pollution, and reclamation of mined areas. 6) from federal agencies and other State agencies who require all conceivable kinds of information related to coal and the coal mining industry.

Current Projects

Active Coal Mine Map.--The map of southwestern Indiana showing the location of active coal mines (Miscellaneous Map No. 7) was revised by Harold Hutchison during January 1971 and republished the following month. Four strip mines were closed and 4 new strip mines began operation. Three underground mines were abandoned and there were no new ones opened during the past year. As of January 1971, there were 4 active underground mines and 38 strip mines. There are 18 separate tipples and loading docks servicing the strip mines. Although the number of coal mines remained about the same, or decreased slightly, coal production in Indiana during 1970 increased from 20 million tons in 1969 to 22.6 million in 1970. Production is expected to increase during the coming year, but enforcement of new federal safety regulations likely will encourage more small mines to close.

Preliminary Coal Maps.--Preliminary Coal Maps have been completed for all coal producing counties except Owen and Greene. Work is now underway to collect data to use in the preparation of Preliminary

Coal Maps for these counties. Although Putnam County has few coal deposits and the county has never had large scale coal production, we plan to complete a map of this county at the same time that work is done in Owen County. Posey County also has large coal reserves but because the coal is deep, there has never been commercial coal mining. Posey County has been the site of increased interest in an acquisition of coal rights by several major coal companies during the past few years. A map is planned for this county in the future.

Distribution of Sulfur in Coal.--A project on distribution of sulfur in coal has been underway for about 2 years. The data have been collected and the results will be prepared for publication in late 1971. During the course of this study bulk samples of coal (2,000 lbs.) were collected from 15 active coal mines in the State. These samples were crushed and separated into 5 different screen sizes. Washability tests then were run on each screen size, after which the samples were separated into six different specific gravity units. Each of these samples were then analyzed for pyritic sulfur (iron sulfide), organic sulfur, and total sulfur.

Results of this work indicate that about one half of the pyritic sulfur can be cleaned from the coal in a preparation plant, although about 20% of the raw coal with its impurities is lost in the preparation process. A separation at a higher specific gravity causes a higher percentage of the raw coal discarded as refuse, but does not significantly increase the efficiency of sulfur reduction. Thus a coal that contained 2 percent organic sulfur and 2 percent pyritic sulfur would end up by having 2 percent organic sulfur and 1 percent pyritic sulfur or a total of 3 percent sulfur. The average sulfur content of the coals in Indiana as shipped to the consumer is about 3 percent.

Environmental Geology of the Evansville Area.--Work was continued on a study of the environmental geology of the Evansville, Indiana area. Much of the attention of this project has been given to the silts and clays of the lake plains. Most of the metropolitan area of Evansville is built on such deposits, and beyond the business and residential area, this kind of land is cultivated rather extensively. Some work was done to determine the porosity and permeability of these materials in order to evaluate their utilization as aquifers and as disposal areas for septic systems.

All available information on underground mining in the urbanized area of Evansville was restudied. Underground mines have been abandoned for many tens of years and are not visible from the surface. However, the voids left by mining are subject to collapse with possible subsidence at the surface. Needless to say this would cause serious damage to existing structures, particularly to underground sewage, water, and gas lines. Outlines of the underground mine areas have been carefully plotted on a map.

The report will be completed in late 1971.

DRAFTING AND PHOTOGRAPHY SECTION

The primary function of the Drafting and Photography Section is to provide service to the commodity and research sections of the Geological Survey. The services offered consist mainly of the final preparation of maps and illustrations for publication and talks, preparation and installation of geology related displays, diazo printing, map and photograph mounting, film developing and printing, copying, color-proofing, photomicrography, field photography, and complete lantern slide preparation.

Final drafting of the following Survey publications was completed: Regional Geologic Map 4, Geologic Map of the 1° x 2° Chicago Quadrangle, Indiana, Illinois, and Michigan, showing bedrock and unconsolidated deposits; Regional Geologic Map 5, Geologic map of the 1° x 2° Muncie Quadrangle, Indiana and Ohio, showing bedrock and unconsolidated deposits; Preliminary Coal Map 14, Distribution, structure, and mined areas of coals in Perry County, Indiana; Misc. Map 17, Map of Indiana showing structure on top of the Trenton Limestone; Bulletin 42-C, Dimension limestone resources of Indiana; Bulletin 42-D, Sand and gravel resources of Indiana; Bulletin 42-E, Native Indiana iron ores and 19th century ironworks; Bulletin 42-F, Specialty sand resources of Indiana; Bulletin 42-G, Marl resources of Indiana; Bulletin 42-H, Crushed stone aggregate resources of Indiana; Bulletin 45, Conodonts from the middle Devonian strata of the Michigan Basin; Special Report 5, Geologic considerations in planning solid-waste disposal sites in Indiana; Report of Progress 30, Glacial lake deposits in southern Indiana; Circular 10, Geology of the Falls of the Ohio River; and Mineral Economics Series 17, Oil development and production in Indiana during 1970. Published maps that were revised during the year are: Misc. Map 7, Map of southwestern Indiana showing locations of active coal mines; Misc. Map 10, Locations of sand and gravel operations in Indiana; Misc. Map 11, Locations of crushed stone operations in Indiana. Two displays were completed for use at the Indiana State Fair and at a petroleum conference. Illustrations were finished for eight outside publications and four talks.

Other projects in progress are: Regional Geologic Maps 6 and 7 (Louisville and Cincinnati Sheets); Preliminary Coal Map 15 (Daviess County); Bulletin 46, Applied geology of industrial limestone and dolomite; Bulletin 47, Subsurface stratigraphy of the West Baden Group in Indiana; Bulletin ___, Geometry and origin of oolite bodies in the Ste. Genevieve Limestone in the Illinois Basin, Special Report 6, Coal strip-mined land in Indiana; Special Report 7, Lithostratigraphy of the Maquoketa Group in Indiana; slide drawings for a paper on conodonts of the Estill Shale; and two displays.

Photographic items produced during the year include 569 camera copies, 690 black and white prints, 388 film positives and duplicate

negatives, 283 stripping film prints of stickup type, 50 black and white slides, 91 color slides, 11 photomacrographs, 10 photomicrographs, 35 scribesheets, 9 color proofs of maps, and 34 field photographs.

Approximately 6,000 prints were produced on the diazo printer.

EDUCATIONAL SERVICES

The Office of Educational Services was established by the State Geologist to coordinate the Geological Survey's efforts in providing information about Indiana geology and mineral resources to the public. This office aids in preparing materials for public schools, youth groups, adult groups, and all persons interested in rocks, minerals, fossils, and the earth. By means of news releases to Indiana's newspapers and articles sent to appropriate magazines, the Office of Educational Services not only aids in informing the public about activities of the Indiana Geological Survey but also aids in the distribution of educational information. In addition to giving public lectures and conducting special field trips, the Educational Services geologist works directly with teachers in public schools, geology clubs, Scout groups, 4-H clubs, conservation clubs, civic groups, and children throughout the school systems of the State on programs or projects concerning Indiana's geology and mineral resources. On occasion he serves as guest lecturer and field trip guide for college classes. The geologist in charge of Educational Services also aids in the preparation and installation of exhibits for fairs, for professional meetings, for amateur rock shows, and for the displays in the Geology Building.

Activities of the Office of Educational Services for the past 12 months were very similar to those of preceeding years. Requests for tours through the Geology Building continued to increase but not significantly.

During the 1970-71 fiscal year the geologist in charge of Educational Services spent 54½ days in the field and traveled 13,976 miles. In answer to requests received from the public, 51 public lectures were given and 36 special field trips and tours were conducted during the 12-month period.

Public lectures, laboratory demonstrations, and film showings were made to the following groups: University School, Bloomington (summer class of elementary and junior high school students); NAVA Rock and Mineral Club, Naval Avionics, Indianapolis; Decatur County 4-H group taking geology projects; Presbyterian Summer Camp, Camp Olivet, Greene County (senior high school students); Hoosier Rock Swap, Marion; Lindberg Elementary School, Lebanon (4th, 5th, & 6th grades); Y.M.C.A. Rock and Mineral Club, Peru; West Terrace Elementary

School, Evansville (4th and 5th grades); Frances Slocum School, Marion (4th and 5th grades); West Newton School, Marion Co. (5th and 6th grades); Elm Heights School, Bloomington (4th grade); Kyana Geological Society, Louisville, Ky.; Schools 61, 107, 79, 84, 26, 27, 109, 90, and 22, Indianapolis, (5th grade) at Bradford Woods; Education 540, Indiana University, Bloomington; Methods of Teaching Science class, Evansville College; earth science and biology classes (convocation type talk), Marion College, Marion; earth science class, Indiana State College, Indianapolis; Bloomfield Lions Club, Bloomfield; the Indianapolis Chapter of the Audubon Society; Grandview School, Bloomington (5th grade); and Meridian School, Kokomo (5th grade).

Special field trips, collecting hikes, and tours were conducted for the following groups: Education 540 students, Indiana University, Bloomington; the participants of the Lawrence County Rock Swap; the participants of the High School Science Institute, Indiana University, Bloomington; Schools 61, 107, 79, 84, 25, 26, 109, 90, and 22, Indianapolis Public School System (at Bradford Woods); Fairview School, Bloomington (6th grade); Childs School, Bloomington (4th grade); Stony Creek Elementary School, Noblesville (6th grade); University School, Bloomington (9th grade earth science classes); St. Charles School, Bloomington, (4th grade); Elm Heights School, Bloomington (4th grade); Union Twp. Elementary School, Rays Crossing (4th, 5th, and 6th grades); Brown Elementary School, Ellettsville (mixed classes); Fairview School, Bloomington (5th grade); Edgewood High School, Ellettsville (9th grade general science class); Fairview School, Bloomington (4th grade); Fayetteville High School, Fayetteville (9th grade); Cub Scout Troup 7, Pack 7, McCalla School, Bloomington; Brownie Scout Troup 223, Bloomington; Cub Scout Troup 107, Packs 1 and 2, Stinesville; and Webelos Pack 102, Bloomington.

Articles submitted and published in OUTDOOR INDIANA included: "Conservation or Conversation," by John B. Patton (July-August 1970); "Yes, We Do Have Tremblors," by Robert F. Blakely (October 1970); "Spring Powered Early Mills," by Richard L. Powell (November 1970); "Indiana's Earth Detectives," by R. Dee Rarick (December-January 1970-71); "Knobstone Escarpment--Scenic Hoosier Landform," by R. Dee Rarick (February 1971); and "The Big Problem for Indiana Coal--Clean But How Clean," by Charles E. Wier (February 1971).

During the past fiscal year the geologist in charge of Educational Services submitted 9 news releases to Indiana's newspapers and aided in the preparation of others about activities of the Geological Survey. Reports of the major news items of the Geological Survey were submitted to the editor of the State Geologists Journal, published semiannually by the Association of American State Geologists. Three issues of the Survey Newsletter were prepared and distributed among the personnel of the Survey and the I. U. Department of Geology during the past year.

Exhibits prepared by the Indiana Geological Survey for public display included a major exhibit for the Indiana State Fair and an

exhibit for the National Petroleum Council Symposium held at Champaign, Illinois. Other Survey exhibits were installed at the Monroe County Fair; the annual Lawrence County Rock Swap; the Glendale Shopping Center in Indianapolis; the Nature Center at Brown County State Park; the annual rock show of the Y.M.C.A. Rock and Mineral Club, held at Peru; the Oilmen's Outing, held at the Crawford County Country Club, Robinson, Illinois; the Nature Center at McCormick's Creek State Park; and the annual rock show of the Grant Geological Society, held at Marion.

The geologist in charge of Educational Services participated in the 16th Annual High School Science Institute, aiding in the presentation of lectures about the field of geology, training for a career in geology, and career opportunities in geology. He also served as co-leader on the local geologic field trip held for the group.

During the 1970 4-H Fair season geology and weather exhibits were judged at the Decatur County 4-H Fair. Assistance was given to several 4-H geology exhibitors who submitted their displays at the Indiana State Fair.

GEOCHEMISTRY SECTION

The commodity and research sections of the Geological Survey rely on the Geochemistry Section to provide chemical analyses of Indiana's rocks and minerals. Because of the wide-ranging requirements of the different sections this work must include the determination of numerous elements in many different forms. Analyses performed by the Geochemistry Section, therefore, utilize a wide range of chemical procedures. These include wet chemical methods, spectrographic, x-ray, atomic absorption and other instrumental techniques.

Although in general analytical instruments permit more rapid chemical determinations than wet chemical methods they must be checked constantly against known standards. This work, with instrument maintenance and the continuing efforts of the Section to develop new and improved methods of sample preparation and analysis require a large part of the geochemist's time.

The analysis of the samples collected by the commodity sections forms a major part of the routine day to day program of the Section. These samples are obtained from cores and from rock material collected at outcrops. The ultimate purpose of this work is to form a complete catalog of the chemical composition of the rocks that underlie our State. From this information we can answer questions about sources of raw materials for new industry, propose new and better uses for our natural resources, and relate rock units of similar ages for geologic mapping programs.

Another large program of the Section has been the study of the composition of Indiana's coals. In addition to providing the basic information needed to insure optimum utilization of our coal resources, the program has acquired data for air pollution studies. By determining the chemical form of sulfur in coal we hope to be able to suggest methods of removing some of the element before coal is burned, or to neutralize the products of combustion.

GEOLOGY SECTION

Introduction

Perhaps the most notable change in the Section's activities during the past few years is the increase in the so-called environmental effort. Much of the formal part of that effort was begun in 1969-70, when one of our personnel (H. H. Gray) was appointed to coordinate the Survey's overall environmental effort and when several formal projects, designed both by area and by special subject, were begun. Only one or two of these projects, or subprojects, were completed, so that for the most part we did not finish the projects begun in 1969-70.

In recognition of the growing environmental emphasis, the Section was able to expand its permanent personnel by employing the Survey's first environmental geologist, so titled (Edwin Hartke). Further, our laboratory work, and employment of laboratory personnel, reached an all-time high, some of it being directed to the environmental projects.

The State's new requirements that govern the operation of sanitary landfills have resulted in this subject being the most common one to which our attention has been directed during the year.

Our accomplishments for the year are summarized in several ways below. In the matter of publication, we cannot detect any trend over the past three years for which we have made a summary like that below. For the year ending we are intermediate in amount of publication, and in amount submitted for publication but are at a high in backlog.

I. Working actively on 10 of 14 investigations having the status of projects and completing 1 of them. Of these 10, 4 are environmental projects, 1 of which has subprojects.

II. Having 10 reports published. One of these is an abstract, and altogether they total approximately 350 pages and 40 illustrations and other exhibitions.

III. Having 3 maps published, 2 of these being Regional Geologic Maps.

IV. Submitting for publication (but remaining unpublished at year's end) 7 reports and 1 map. Of these reports, 1 is an abstract, and they total 226 typescript pages and 63 illustrations and other exhibitions.

V. Preparing 17 other formal reports (not for publication) in answer to specific requests. These reports total 72 pages and 26 illustrations, and 10 of them are on landfills.

VI. Maintaining a backlog of 10 reports, totaling 632 pages and 98 illustrations and other exhibitions, and 1 map that await publication.

VII. An incomplete tabulation of the kinds of conferences has been made, both by subject matter and by requestor and beneficiary:

Number of conferences by subject matter

Landfills	42	General education	18
General geologic information	36	Engineering and natural damage problems	13
Fossils and paleontology	33	Economic deposits	9
Water, drainage, soils and pollution	21	Planning needs	7
		Legal problems	4

Requestors and/or beneficiaries of conferences (one office or organization counted only once)

Indiana counties	20	Federal offices	7
Businesses and industries	15	State offices & property	6
Universities and colleges represented	15	Professional organizations and service clubs	4
Indiana cities	13	Offices, other states	3
Planning & other consultants	10	Foreign offices	2
		Private individuals (not counted)	

Service and Applied Activities

Most of the work described here may be classified into three broad categories: 1) specific projects in the coordinated environmental program, 2) work in response to specific requests, mostly from outside the Survey, and 3) regional geologic mapping.

Environmental geology, including planning, engineering, and water considerations.--The year 1970-71 was the fourth in which much of our function was carried on under the label environmental geology; it is the second year of operation, however, of the new environ-

mental effort that has had several specific projects begun and that is coordinated by Henry Gray for the entire Survey.

I. Landfills. Because of the relatively new State requirements governing the operation of landfills, much of our applied effort continued to be directed to this matter. A new project was begun in cooperation with the Indiana University Water Resources Research Center to study the effects of leachates on groundwater quality in nearness to landfills. The Section is to provide basic geologic data, and some boring control, and possibly some water observations. The landfills examined during 1970-71 are in Monroe and Bartholomew Counties. The dozens of conferences of record on landfills further attests to the important role the Section has had in answer to the State's increasing problem on waste disposal.

II. Physical properties of geologic units. The project that was begun (and described) in the previous year to describe the engineering and use characteristics of all the major bedrock and unconsolidated deposits throughout the State was continued to near completion. The importance of one study of glacial lake deposits is reflected in the fact that 1/18 of the State's surface is occupied by these deposits, which have offered repeated problems in construction and land use.

Activities in the sedimentation laboratory continued to be devoted mostly to the determination of physical properties, including textural and mineralogical aspects, such determinations also being applicable to basic research projects described elsewhere. Some 3,355 tests (potential volume change, Atterbury limits, carbonate, magnetic susceptibility, textural, x-ray, field compressive strength, pebble count) were made.

III. Environmental projects designated geographically. The three projects designated by urban and county units that were begun (and described) last year were continued. Some reached near completion, but work has progressed less rapidly than had been hoped.

Floyd and Clark Counties. Sixty percent completed. The report and map probably will be for the New Albany-Jeffersonville area, rather than for the entire counties.

Allen County. Forty-five percent completed.

Lake and Porter Counties (incorporates old project on Pleistocene geology of Calumet area). Fifty percent completed.

A report and manuscript entitled Urban Geology of Madison County (Wayne, W. J., 31 p., 6 pls., 1 fig., 3 tables) has now been mentioned in three earlier annual reports, but it remained completely inactive during 1970-71 because of our failure to obtain the remaining revision from the author.

Research Activities

During the past few years, including the last one, our research activity has fallen off as the environmental program took up much of our effort and as financial requirements have limited our employment of temporary personnel. Nevertheless, there were two areas in which considerable activity is notable, one is biostratigraphy and paleontology and the other in analyses of unconsolidated deposits, especially tills.

Stratigraphy, biostratigraphy, and paleontology.--Middle Paleozoic geology of the southern part of the Michigan Basin. This project has been described in several earlier reports, once had National Science Foundation support, and was advanced during 1970-71 in both paleontological and stratigraphic aspects.

As an outgrowth of two projects (Quantitative geomorphology of southern Indiana and the environmental project on southern Indiana glacial lake deposits), an effort was begun to recover pollens from glacial lake sediments of southern Indiana. The objective is to reconstruct the vegetational history during the past 100,000 years approximately and to apply it to correlation of deposits and events, including events in an erosional history. Some pollens have been recovered, and a recovery technique was worked out.

Pleistocene stratigraphy and till studies. Although much of our effort has been directed toward gaining a better understanding of Pleistocene stratigraphy, most of it has been an applied effort, whether directed to the Regional Geologic Map or to environmental studies, and it is so reported herein. Nevertheless, a great many Pleistocene samples were collected and shallow borings and logs made, some of the samples coming from State Highway Department projects. Further a great many basic data were obtained from several kinds of tests made in the sedimentation laboratory (textural, carbonate, mineralogical, x-ray, magnetic susceptibility, pebble-count, and engineering type tests), some of which are also to be applied to environmental projects. All these data and logs form a reservoir of information that we hope will result in meaningful, synthesized research results, but during the past year the environmental effort has fairly well taken the time needed for basic synthesis and interpretation.

These projects, all described in earlier reports, saw some progress through the collection of data and samples and performance of tests as noted above. 1) Pleistocene stratigraphy of west-central Indiana. 2) Characteristics of Indiana tills. 3) Pleistocene geology of Calumet region. Discontinued but merged in environmental project for Lake and Porter Counties. 4) Project, remaining essentially inactive: Stratigraphy of Upper Chester rocks.

Editorial, Committee, Educational, and Other Assorted Activities

Most of our personnel belong to intra- or extra-Survey committees or otherwise perform editorial, reviewing, field trip, and chairmanship duties for the Survey and other organizations. The Geologic Names Committee handled 16 manuscripts and maps of record. The traffic of manuscripts and maps through the Geologic Names Committee is one index of productivity of the Survey. During the past seven years (1965 through 1971), these numbers of items have been recorded in order: 30, 24, 15, 30, 18, 19, and 16.

Bleuer helped to conduct Field Trip No. 4, Pleistocene geology and geomorphology of southern Wisconsin, for the Milwaukee national meeting, November 1970, Geological Society of America. Two publications resulted, for which part of Bleuer's effort was expended prior to present employment.

Gray continued to serve as chairman of a committee that is to coordinate activities of the Survey's intersectional environmental program. He also was co-chairman of a straitgraphy session of the North-Central Section, Geological Society of America, meeting in Lincoln, Nebraska, April 1971.

Shaver completed his membership stints on two committees of the Society of Economic Paleontologists and Mineralogists: 1) Publications Committee (chairman) and 2) joint SEPM - Paleontological Society Committee to study financial problems of the Journal of Paleontology.

GEOPHYSICS SECTION

During the 1970-71 fiscal year the Geophysics Section worked on field surveys by seismic reflection and seismic refraction methods. In the laboratory the Section's continuing program to determine the physical properties of Indiana rock units utilized density, crushing strength, abrasion, radioactivity, and other tests to determine the properties of rocks that influence their use. In order to handle the large quantity of data that is produced by geophysical measurements, the Geophysics Section utilized both analog and digital computers. The Section also was in charge of the operation of the Survey's Failing Model 1500-S drilling rig and a truck-mounted auger capable of augering to depths of 100 feet.

Seismic Surveys

A large seismic refraction survey and a smaller seismic reflection project were worked on by a seismic crew during the summer field season and most of the fall. The seismic refraction survey was done

in connection with the geologic work that will form the basis of the preliminary coal map of Greene, Owen and Putnam Counties. Seismic measurements were made to determine the thickness of unconsolidated deposits above bedrock. From this information geologists are able to determine amounts of coal that have been removed by erosion and thereby obtain better estimates of the reserves of coal remaining underground. This project ultimately will require more than a thousand seismic refraction shots.

The seismic reflection surveys covered traverses in southwestern Indiana and in the west central part of the State. Seismic shots were taken over parts of Indiana that are underlain by the Borden Group in an effort to detect changes in rock types from one locality to another. The character of the reflections or changes in reflection quality are expected to indicate these changes of rock type within the Borden. The project had the secondary purpose of adding to our knowledge about the thickness of the sedimentary section and the depth to the Pre-Cambrian basement in western Indiana.

Laboratory Studies

Each core that is received by the Survey is sampled for laboratory tests of physical properties. Special samples also are received from industry and from trade associations in order that we may assist in the development of tests and specifications for stone that is to be used for specific purposes.

The Section continued a vigorous program of computer utilization. A powerful array of equipment was available for many specialized applications. Routine computation of geophysical data was continued on the Survey's G-15 computer. More complex programs were handled by teletype communication with the large machine at Indiana University's Research Computing Center, and special problems were taken to the Varian Computer in the Department of Geology. Problems which require differential equations for solution and modeling studies are directed to the Section's analog computer.

The program to encode data from all of the oil wells for which the Survey has records continued. By the end of the year well data from 89 counties had been punched onto cards. When completed this project will enable geologists to obtain rapid collections of data about particular areas, rock type, formations, production and other categories that have been encoded.

INDUSTRIAL MINERALS SECTION

The principal function of the Industrial Minerals Section is to gather, organize, and store geologic information about the industrial rocks and minerals so that it can be readily distributed to the general public. A subordinate function, but one of almost equal importance, is to conduct research that will increase our overall understanding of the geology of the industrial rocks and minerals in Indiana.

The Section has been particularly effective in accomplishing our primary function. The 333 requests for information we handled last year was an all-time high in service. These results are particularly satisfying when considered that the Section had the services of only 3 geologists during 10 months of the fiscal year. Even with this exceptional load of service work, the Section was able to increase over last year its number of man-days in the field, the thickness of core described, the thickness of holes augered, number of samples collected for chemical analyses, and number of mineralogic analyses.

In order to maintain this high level of service work, the Section's time for research suffered appreciably. Although our diminished research has not been felt this year, it will affect the Section's future program. Today's research becomes our source of information for tomorrow's service.

Service

The Section handled requests for information for virtually all industrial minerals in the State, including limestone, dolomite, clay and shale, gypsum, sand and gravel, specialty sand, peat, marl, and building stone. Some of these requests were handled with very little effort; other requests required extensive compilation of data and field examination.

The Section was particularly pleased to see new quarry operations begin in Lake, Grant, Lawrence, and Washington Counties, because each of these new operations made use of information supplied by the Survey.

Projects in process

A report on the lime industry in Indiana was nearly completed. Studies on the utilization of fly ash and the geology of the Kankakee Valley dune sands was slowed down because of more pressing work on the environmental geology of Allen County. A study of the mineral resources of the Big Blue River Valley in Henry and Rush Counties was begun. The project to locate abandoned limestone

quarries in the State has been successful in locating more than 875 quarries. Studies of both the Lost River Chert and the limestone resources in the Ohio River Valley in Indiana received little attention during the year. A new project to study the clay and shale resources of the State directs attention to a mineral resource that has been neglected for several years.

MINERAL STATISTICIAN

An all-time high value of $274,613,395.00 was reached in 1970 for minerals and products made from them. This 3.18 percent increase over 1969 production value is credited almost entirely to the coal and clay products industries, which showed substantial gains, as all others, with the exception of gypsum and natural gas, showed decreases ranging from 1.76 to 32.10 percent.

Greatly expanding needs for electrical power account for the increases of 11 percent in quantity and 23.5 percent in value of coal mined during the year. Approximately 40 percent of production went for this purpose.

Petroleum production continued to decline, but at a lesser rate than in the several previous years. Natural gas showed an increase of 32 percent in volume and 34 percent in value, but some of this may have been 1969 production which was not reported until 1970.

Excepting gypsum, which increased slightly over the previous year, and the products manufactured from clay and shale, which showed substantial gains, all building materials declined in both volume and total value. More complete and accurate figures probably account to some extent for the favorable picture presented by the clay products industry. A general slowdown in building construction explains some of the decline in dimension stone sales, and concrete and other materials gained an increasing share of the construction market. A factor affecting the gross value of the dimension limestone industry in Indiana is that a greater proportion of the stone is shipped out of the state in rough blocks or sawed slabs, which are less expensive than cut stone, for fabrication nearer the building site. Freight rates are considerably less for unfabricated stone than for cut stone.

Production of crushed limestone declined almost 9 percent in quantity and slightly under 2 percent in value. Sales of agricultural limestone increased by one-third over 1969, but stone for all other uses decreased.

Production of sand and gravel decreased almost 14 percent in volume and 10 percent in value. Sand for paving purposes increased slightly, but for all other purposes sales remained approximately

the same as in 1969 or declined.

Three counties reported minerals production valued in excess of $20 million, four counties reported production between $10 million and $20 million, and six counties reported production between $5 million and $10 million. These counties are listed below, together with the commodities produced.

$20 million +

Warrick County	$33,909,253.00	Coal, crushed limestone.
Sullivan County	26,659,200.00	Coal, crushed limestone, sand and gravel.
Lake County	21,153,402.00	Cement, clay and shale, clay products, sand and gravel.

$10 million - $20 million

Pike County	$19,109,106.00	Coal.
Lawrence County	17,939,958.00	Cement, crushed limestone, dimension limestone, dimension sandstone.
Clay County	17,681,212.00	Clay and shale, clay products, coal.
Clark County	15,615,003.00	Cement, clay and shale, crushed limestone, sand and gravel.

$5 million - $10 million

Monroe County	$ 9,323,962.00	Crushed limestone, dimension limestone
Putnam County	8,808,197.00	Cement, crushed limestone, sand and gravel.
Greene County	6,924,458.00	Clay and shale, clay products, coal, sand and gravel.
Montgomery County	6,107,962.00	Clay and shale, clay products, sand and gravel.
Cass County	5,679,469.00	Cement, clay and shale, crushed limestone, dimension limestone, sand and gravel.
Vermillion County	5,460,421.00	Clay and shale, clay products, coal, sand and gravel.

Twenty counties reported mineral production valued between $1 million and $5 million. Although petroleum, natural gas, and peat are produced in some of these counties, they are not included in the figures listed above as information is not available on a county basis.

	1969		1970		% Inc. or Dec.	
	Quantity	Value	Quantity	Value	Quantity	Value
Coal	20,658,885 T	$81,467,493.00	22,359,943 T	$100,619,744.00	+ 11.43	+ 23.51
Cement (portland and masonry)	16,905,163 B	51,716,546.00	14,720,968 B	43,018,386.00	- 12.92	- 16.82
Petroleum	7,841,468 B	24,386,965.00	7,486,798 B	23,957,754.00	- 4.52	- 1.76
Clay and Shale						
(Raw materials)	1,139,080 T		1,251,904 T		+ 9.90	
(Manufactured prods.)		17,891,643.00		24,886,487.00		+ 39.10
Limestone, dimension	5,305,727 CF	21,685,474.00	4,643,993 CF	15,563,904.00	- 12.47	- 28.23
Limestone, crushed	25,515,510 T	34,318,123.00	25,286,521 T	35,030,016.00	- 8.97	- 1.78
Sand and Gravel	27,027,829 T	28,302,770.00	23,282,545 T	25,605,557.00	- 13.86	- 9.53
Natural Gas	178,880,000 CF	25,632.00	237,000,000 CF	34,400.00	+ 32.49	+ 34.21
Peat	38,214 T	515,000.00	33,632 T	405,023.00	- 11.99	- 21.35
Marl	25,968 CY	19,629.00	23,915 CY	14,106.00	- 7.90	- 28.14
Undistributed: (includes alumina cement, gypsum, dimension sandstone, whetstones)		8,607,852.00		7,964,690.00		- 7.47
TOTAL - adjusted to avoid duplication for clay, stone, and sand used in cement.		$266,157,460.00		$274,613,395.00		+ 3.18

PETROLEUM SECTION

Work in the Petroleum Section consists of services, projects that are repeated annually, projects related to records improvement, subsurface study projects, and, from time to time, special projects. The work pattern of the Petroleum Section has varied little for years.

Services

Most services rendered are related to, and almost entirely dependent upon, the comprehensive, continuously-expanding file of well data maintained in the Petroleum Section. The services related to this file consist of correspondence and conferences about samples, cores, geophysical logs, scout data, drillers logs, drilling-time logs, well locations and elevations, etc., and interpretations made from these data.

Annual Projects

Five projects that have been undertaken annually for many years were completed during the year. Much, but not all, of the work involved in these projects is of a statistical nature.

Indiana Drilling Statistics.--Indiana drilling statistics, in accordance with the well classification format specified by the American Association of Petroleum Geologists' Committee on Statistics of Drilling, were developed for 1970; these statistics are utilized by the AAPG and the American Petroleum Institute in compilation of statistical summaries covering drilling in the whole of the United States. Indiana drilling statistics were compiled, also, in accordance with the well classification format employed by the Geological Survey for many years; these statistics are published in the Geological Survey's annual publication on oil production.

Indiana Exploration Developments.--A review of the results of exploratory drilling in Indiana during 1970 was compiled. It is published in a bulletin of the American Association of Petroleum Geologists, as a part of a national review of exploration results.

Indiana Oil Production.--Indiana oil production statistics, by fields, for 1970 were prepared. Publication of these statistics is by the Geological Survey in its Mineral Economics Series; the volume for 1970 will be the seventeenth of the series.

Indiana Oil Reserves.--The Petroleum Section participates annually in the American Petroleum Institute's program of formulating statistics on remaining oil reserves and developing attendant oil-recovery data. The Section's statistical contributions to the API reserves program pertain mainly to Indiana. Reserves and attendant

data for Indiana are incorporated in a publication of the American Petroleum Institute, the American Gas Association and the Canadian Petroleum Association. Only state-total figures are published.

Review of Petroleum Exploration Map Series.--This map series consists of county well-location maps, scale 1 inch equals 1 mile, showing wells by the standard classes (dry hole, oil well, gas well, etc.) and total depths. All of the 92 maps in the series were reviewed, updated and re-issued as of December 31, 1970.

Records Improvement

Upgrading well records has been a continuing program for 20 years. The program encompasses all of Indiana's 92 counties except the seven in which the oil reservoirs of the Trenton Field are located, where vintage of drilling precludes upgrading. Of the 85 counties included in the program, 83 have been completed. The two remaining counties are Posey and Gibson. These are the most densely drilled counties of the 85, and thus a very large amount of work remains to complete the program. Work currently is restricted to Posey County.

Because of high well density, the Posey County project is divided into subprojects on a congressional township basis. Two townships were completed last year and four were completed this year. Of the remaining 13 townships, work is underway on nine, progress on them ranging from 20 to 85 percent completion.

Subsurface Studies

Only one subsurface study is in progress. It is a study of the thick Cambrian clastic section of Indiana. It was initiated at the beginning of the year and is 35 percent completed. It will add significantly to understanding of Indiana subsurface strata and will be published by the Geological Survey, probably as a bulletin.

Special Projects

One special project, started at the beginning of the year, is in progress. It is compilation of a new pipeline map of Indiana. The Geological Survey published a detailed pipeline map of Indiana in 1960. It now is out-of-date and out-of-print and many new pipelines, mostly for gas, have been built in Indiana in the past 11 years. Compilation of the new pipeline map is 70 percent complete.

Miscellaneous Notes

Outside Publications.--The American Association of Petroleum Geologists' Memoir 15 is titled "Future Petroleum Provinces of the United States." Just published, it is a 1500-page, two-volume publication made up of 11 discrete papers pertaining to petroleum and prospective petroleum discovery in different parts of the United States. The paper titled "Region 9" pertains to the Cincinnati Arch, Illinois Basin and the upper part of the Mississippi Embayment. Members of the Petroleum Section made a major contribution to the Region 9 paper.

Technical Programs.--Two members of the Petroleum Section were panelists at the symposium on "Future Petroleum Potential of NPC Region-9", held in Champaign, Illinois in March, 1971. Also, one member participated in a technical program of the Midwest Gas Storage Section, Society of Petroleum Engineers (AIME), held at Pontiac, Illinois in May, 1971; the subject of the technical program was potential areas of gas storage in northern Illinois and northern Indiana.

Technical Committees.--One geologist of the Petroleum Section is a member of the American Petroleum Institute's subcommittee for crude oil reserves data in the tri-states area of Illinois, Indiana and Kentucky; he participated in the annual meeting of the subcommittee in St. Louis, Missouri in January, 1971. One geologist of the Section is a member of the API's national committee on crude oil reserves and participated in subcommittee meetings in Lansing, Michigan and St. Louis in January, 1971 and in the annual meeting of the national committee in Banff, Canada in March, 1971. And one geologist of the Section is a member of the American Association of Petroleum Geologists' committee on statistics of drilling and attended the meeting of the committee in Washington, D.C. in October, 1970.

Professional Societies.--Five members of the Section are active participants in the Indiana-Kentucky Geological Society and one member is an active participant in the meetings of the group known as Indiana Geologists. Four are long-standing members of the American Association of Petroleum Geologists and two hold membership in the Geological Society of America.

PUBLICATIONS SECTION

During the past fiscal year the Publications Section sold 5,915 reports and 8,735 maps. The section sent 1,693 reports and 344 maps on exchange to institutions in the United States and in foreign countries. It also distributed without charge 2,360 reports and 2,610 maps to members of its own organization and to

individuals, libraries, and companies in the United States and abroad. The Publications Section served 3,217 office customers, handled 2,009 letters pertaining to geologic reports and maps, and sent out 1,669 announcements of new publications.

As one might expect, best sellers are numbers in the Circular series. The biggest seller is Circular 5, "Let's Look At Some Rocks" (published 1958, 29,000 copies in print). It is followed by Circular 6, "Adventures With Fossils" (published 1959, 12,000 copies in print); Circular 7, "Fossils: Prehistoric Animals in Hoosier Rocks" (published 1960, 9,000 copies in print); Circular 4, "Guide to Some Minerals and Rocks in Indiana" (published 1958, 8,000 copies in print); and Circular 8, "Caves of Indiana" (published 1962, 6,000 copies in print).

REPORTS AND MAPS PUBLISHED

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Carr, D. D. and Webb, W. M., 1970, Sand and gravel resources of Indiana: Bull. 42-D, 31 p., 20 figs, 2 tables.

Rooney, L. F., 1970, High-calcium limestone and high-magnesium dolomite resources of Indiana: Bull. 42-B, 20 p., 1 pl., 1 fig., 5 tables.

Rooney, L. F., 1970, Dimension limestone resources of Indiana: Bull. 42-C, 29 p., 21 figs., 1 table.

Shaver, R. H., and others, 1970, Compendium of rock-unit stratigraphy in Indiana: Bull. 43, 229 p., 1 pl., 8 tables.

Wayne, W. J., 1970, Native Indiana iron ores and 19th century ironworks: Bull. 42-E, 25 p., 10 figs.

Circulars

Powell, R. L., 1970, Geology of the Falls of the Ohio River: Circ. 10, 45 p., 13 figs.

Directories

Indiana Geological Survey, September 1970, Directory of crushed stone, ground limestone, cement, and lime producers in Indiana: IBM printout, 42 p.

Mineral Economic Series

Carpenter, G. L. and Keller, S. J., 1970, Oil development and production in Indiana during 1969: Mineral Economics Ser. 16, 18 p., 2 figs., 4 tables.

Reports of Progress

Gray, H. H., 1971, Glacial lake deposits in southern Indiana--engineering problems and land use: Rept. Prog. 30, 15 p., 1 pl., 8 figs., 1 table.

Special Reports

Bleuer, N. K., 1970, Geologic considerations in planning solid-waste disposal sites in Indiana: Spec. Rept. 5, 7 p., 1 fig.

Miscellaneous Maps

Carr, D. D., 1964, Rev. 1971 by M. C. Moore, Locations of sand and gravel operations in Indiana: Misc. Map 10.

Dawson, T. A., 1971, Map of Indiana showing structure on top of Trenton Limestone: Misc. Map 17.

French, R. R., Carr, D. D., and Sunderman, J. A., 1965, rev. 1970 by C. H. Ault and D. D. Carr, Locations of crushed stone operations in Indiana: Misc. Map 11.

Hutchison, H. C., 1962, rev. 1971, Map of southwestern Indiana showing locations of active coal mines: Misc. Map 7.

Indiana Geological Survey, 1970, Map of Indiana showing bedrock geology: Misc. Map 16.

Preliminary Coal Maps

Hutchison, H. C., 1971, Distribution, structure, and mined areas of coals in Perry County, Indiana: Prelim. Coal Map 14.

Regional Geologic Maps

Gray, H. H., Wayne, W. J., and Wier, C. E., 1970, Geologic map of the 1^{o} x 2^{o} Vincennes Quadrangle and parts of adjoining quadrangles, Indiana and Illinois, showing bedrock and unconsolidated deposits: Regional Geol. Map 3. Part A, map showing bedrock only, and Part B, map showing unconsolidated deposits only, are also available.

Schneider, A. F., and Keller, S. J., 1970, Geologic map of the 1^{o} x 2^{o} Chicago Quadrangle, Indiana, Illinois, and Michigan, showing bedrock and unconsolidated deposits: Regional Geol. Map 4. Part A, map showing bedrock only, and Part B. map showing unconsolidated deposits only, are also available.

MEMORANDUM REPORTS

Ault, Curtis H., July 1970, History of the use of crushed stone in the cement industry in Indiana.

Ault, Curtis H., July 1970, History of the use of crushed stone for production of lime in Indiana.

Ault, Curtis H., Carr, D. D., Moore, M. C., Hartke, E. H., and Hill, J. R., December 1970, Mineral resources and environmental geology reports for southern Lake and Porter Counties near a proposed regional airport.

Bleuer, N. K., July 29, 1970, Summary of geologic limitations for sanitary landfills in Monroe County, Indiana, 1 p., 1 fig.

Bleuer, N. K., August 6, 1970, Geology of Marion County with respect to proposed sanitary landfill operations, 6 p., 1 map, appendices.

Bleuer, N. K., Sept. 17, 1970, Results of reconnaissance drilling in Sec. 17, T. 23 N, R., 4 W, and interpretations regarding a proposed sanitary landfill for Lafayette, Indiana, 5 p., 3 fig., appendix.

Bleuer, N. K., September 24, 1970, Preliminary geologic appraisal of proposed sanitary landfill site in the NW$\frac{1}{4}$ Sec. 32, T. 8N, R. 1W, Monroe County, Indiana, 6 p., 1 fig.

Bleuer, N. K. and Fix, Wayne, October 14, 1970, Summary of geologic limitations for sanitary landfills in Monroe County, Indiana, 4 p.

Bleuer, N. K. and Hartke, E. J., October 30, 1970, Geologic considerations in planning a solid waste disposal site in the SW$\frac{1}{4}$, NE$\frac{1}{4}$, Sec. 30, T. 6N, R. 5W, Spencer, County, Indiana, 2 p.

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ACTIVITIES

Ned K. Bleuer - Co-leader of field trip no. 4, Pleistocene geology and geomorphology of southern Wisconsin for November 1970 meeting of Geological Society of America.

Donald D. Carr - Great Lakes Basin Study Commission: Committee on Mineral Resources.

Forum on Geology of Industrial Minerals: Steering Committee.

T. A. Dawson - American Petroleum Institute: national committee on crude oil reserves.

Henry H. Gray - North-Central Section, Geological Society of America, Lincoln, Nebraska, April 1971: co-chairman of a stratigraphy session.

Stan Keller - Indiana Geologists.

Indiana-Kentucky Geological Society.

R. K. Leininger - Geochemical Society

American Association for Advancement of Science.

Society for Applied Spectroscopy.

American Chemical Society.

Clay Minerals Society.

Spectroscopy Society of Canada.

Mineralogical Association of Canada.

Monroe County Soil & Water Conservation District: Supervisor, board member, treasurer.

Louis Miller - Indiana Geologists: Secretary-treasurer.

Indiana Mining & Technical Society: Secretary-treasurer.

Indiana Coal Mining Institute.

Indiana Academy of Science.

Richard Powell - Board of Geographic Names.

John B. Patton - ASTM: Committee C-18 Natural Building Stones, chairman, Limestone Specifications Subcommittee; Definitions and Nomenclature Subcommittee.

National Association of State Universities and Land Grant Colleges: Mineral Resources Subcommittee.

Society of Economic Geologists Council.

Interstate Oil Compact Commission: Research Committee.

American Association of State Geologists: Liason Committee, chairman of committee to provide President of National Academy of Sciences with nominees for new Director of USGS.

American Institute of Mining, Metallurgical, and Petroleum Engineers: Publication Advisory Committee.

Ohio River Valley Water Sanitation Committee: committee on waste water injection.

Indiana Academy of Sciences: chairman of Research Grants Committee and member of Science & Society Committee.

National Research Council: Division of Earth Sciences.

R. Dee Rarick - 16th Annual High School Science Institute, co-leader of field trip.

Lawrence F. Rooney and Donald Carr - American Institute of Mining and Metallurgical Engineering, St. Louis, Missouri.

Robert Shaver - Society of Economic Paleontologists and Mineralogists: Publications Committee (chairman) and joint SEPM - Paleontological Society Committee.

Dan M. Sullivan - American Petroleum Institute: Subcommittee for crude oil reserves data in the tri-states area of Illinois, Indiana and Kentucky.

American Association of Petroleum Geologists.

Indiana-Kentucky Geological Society.

Charles Wier - Geological Society of America: Chairman, Carboniferous Stratigraphy Committee and co-chairman of session on coal geology.

Indiana Academy of Science: Committee on Science and Society, Population and Environment Subcommittee.

Office of Emergency Planning: Director of Solid Fuels Task Force.

Monroe County Soil and Water Conservation District: Assistant Supervisor.

LECTURES

Donald D. Carr - "Paleocurrents influencing deposition of some Ste. Genevieve oolitic limestones in the Illinois Basin" to Southern Section, Geological Society of America, May 6, 1971.

"Ste. Genevieve oolitic limestones in the Illinois Basin" to the I. U. Department of Geology Colloquium, February 22, 1971.

R. K. Leininger - "Availability of geochemical standards" to the Society of Applied Spectroscopy at Dayton, Ohio, November 17, 1970.

Michael Moore - "Caves in northeastern Mexico" to the Mid-Illinois Grotto, Urbana, Illinois, May 6, 1971.

John B. Patton - "Geology and environment in interdepartmental programs" on I. U. campus, December 1, 1970 and May 6, 1971.

"The immortal clay", presidential address at Phi Beta Kappa initiation banquet, December 17, 1970.

"Material Outlook for the midwest--industrial minerals and fuels" in symposium at dedication of Geology Department facilities, Western Michigan University, Kalamazoo, Michigan, April 24, 1971.

"Geology of Indiana gypsum deposits and the Spring Mill Region" at annual meeting of Garden Clubs of Indiana, Spring Mill State Park, September 9, 1970.

"Natural resources and the environment" in Environmental Studies Seminar for High School teachers at B.H.S., Bloomington, Ind., March 10, 1971; and in Environmental Workshop sponsored by the Department of Journalism and Focus: Environment Program, I. U., April 15, 1971.

Richard Powell - "Caves of Indiana" at the State Fair, September 3, 1970 and to I. U. Spelunking Club, September 24, 1970.

"Some physical factors concerning land use on the Mitchell Plain of south-central Indiana" to the annual meeting of Indiana Academy of Science at Terre Haute, November 6, 1970.

"Features of Lost River" to a study group of the Sassafrass Chapter of the Audubon Society, February 16, 1971.

Addressed a meeting on the conservation and recreational development of southern Indiana in Bloomington, April 13, 1971.

Charles Wier - "Future of Indiana coal--fact or fairytale?" at the annual meeting of the Indiana Coal Mining Institute in Evansville, March 27, 1971.

"Sulfur in Indiana coals" at the Geology colloquium, I. U., April 26, 1971.

Addressed meeting of the Indiana Academy of Science Population and Environment Committee at Purdue University, October 24, 1970.